BALLOON OZONE MEASUREMENTS IN COLLABORATION WITH SAGE III

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Background:

In response to request resulting from NASA RA97 - MTPE - 03 we proposed to provide correlative validation measurements in support SAGE III. Vertical ozone is to be measured using the Electrochemical Concentration Cell ozonesonde from Wallops Island, Natal, Brazil, and Ascension Island. The excellent Brazilian Air Force facility located near Sao Luis, Brazil, also was proposed as an alternate location to obtain measurements as well.

The proposed effort was to obtain measurements of the the total ozone overburden using the Dobson Spectrophotometer located at Wallops Island along with the vertical distribution of ozone, temperature, relative humidity, pressure, and wind. Measurements from Natal, Brazil would include vertical ozone measurements that would supplement the existing ozone observations from Natal. A Dobson also is located at Natal and we would expect to obtain total overburden measurements from that location also. The inclusion of Sao Luis was an opportunity to obtain additional vertical ozone measurements from a site closer to the Equator and further west by about 700 miles. It was recommended that this site be implemented in order to obtain some redundancy near the Equator. Ascension Island in the eastern South Atlantic ocean was also proposed since it gave further opportunities for redundancy near the Equator, The proposal also had provision to use handheld photometers to obtain ozone total overburden, aerosol optical depth, and precipitable water.

The measurement strategy proposed was to obtain nighttime correlative measurements in coincidence with SAGE III when the satellite was making lunar occulatation measurements and calibrations. The number of lunar measurement opportunities that would be available was unclear at the time of the proposal so 30 correlative ozonesonde observations per site was estimated as necessary. Data would be delivered to the Upper Air Instrumentation Research Project group of Code 972 for quality checking, forwarded to the Science Team members, made available on the Langley and Goddard DAAC ‘s and would also be deposited in the World Ozone and Ultraviolet Data Center in Toronto.

The cost of the original proposal was revised upon request of the EOS Cal/Val Manager. The revised proposal also indicated the possibility of ozonesonde launchings from Kwajalein Atoll. The acceptance of the proposal to support SAGE III measurements was received in an approval letter dated September 17, 1997.

Meetings:

I attended the Workshop for Atmospheric Validation in EOS-AM1 and SAGE III held at Hampton University during October 1997. At this meeting contact was made with a number of the SAGE team members. It was obvious that the validation measurements required, other then ozone, might also be available through the efforts of the proposal. These would be unfunded for any measurements made at a location other then Wallops. Nonetheless, rocketsonde measurements were suggested as a possible validation tool. Dr. McCormick acknowledged that temperature validation to about 85 km would be very useful. Brazil was suggested as a possible site since a new agreement between NASA and INPE was in the process of being prepared. Other possible validation measurements we can provide are accurate temperatures to approximately 40 km with the NASA developed ATM (Accurate Temperature Measurement) radiosonde that can provide temperatures to within 0.3-0.4%C in the stratosphere, and improved relative humidity measurements using chilled mirror technology (currently available and undergoing evaluation). The need for validation was discussed and plans for future activities were mentioned.

A SAGE III Science Team meeting was attended at Hampton University during March 1998. Discussions on validation of the various SAGE III measurements were conducted. At this meeting it was clear that not only ozone validation was important but so was water vapor and aerosols. Frost-point balloonsondes were mentioned as a correlative validation method for water vapor. At the time the chilled mirror technique being tested at Wallops. The chilled mirror is a 'piggyback' instrument attached to the SIPPICAN (Formerly VIZ) MK-2 radiosonde. This instrument is flown on a routine meteorological balloon and a decoder between the receiver and computer, of which we have three available, provides the proper meteorological units. At the time of this meeting the on-time launch of SAGE III was debatable. This delay of the launch of METEOR3M was a factor in how fast we needed to prepare. Sites where ozonesonde balloon measurements. But, it appeared at the time that extra effort getting ready to provide validation measurements was not a factor. Capability already in place at Ascension Island, Natal, Brazil, and Wallops Island would require additional supplies of expendables and some additional training. The agreement between NASA and INPE for the launch of ozonesondes from Natal was progressing slowly but did reach final approval in September 1998.

During February 1999, the meeting in Tucson AZ concerning SAGE III and the SOLVE programs, addressed the issue concerning the timing of the ozonesonde validation measurements. It appeared that September 1999 could be the time when METEORS3M would be launched. Again we realized that preparing to provide validation measurements would not require a long spin-up therefore, until SAGE III was on orbit our preparation was put on hold. With exception of obtaining expendables, other necessary hardware (which is an ongoing task), and whatever additional training was needed, we virtually were ready.

On February 23-24, 2000 a SAGE III meeting was held at Hampton University, Hampton, Virginia. System readiness was discussed and the launch of SAGE III for December 2000 was confirmed. (As of today-24 May) the schedule is still for launch during December. The requirement for lunar validation was reiterated. The importance of reliable and accurate temperatures was discussed. The sense of the meeting conveyed some ideas that we are

implementing, for example, the presentation of ozone mixing ratio, the addition of wind information, when available, and the requirement for water vapor measurements which can be provided by this group.

Activities:

I. Agreements:

A new agreement between NASA and INPE was concluded in September 1998. This agreement covers a 10-year period. The agreement also has provision for obtaining measurements from Alcantara, Brazil (2S). Alcantara is a Brazilian Air Force Launch Range and is equipped to launch balloons and rockets. If ozonesondes are to be launched from Alcantara INPE must be requested to make a separate internal agreement with their Air Force to meet SAGE III lunar ephemeres. The Brazilian Air Force personnel located in Sao Luis dos Campos also are anxious to launch rocketsondes for SAGE III. Recently, upon requesting INPE and CTA (Brazilian Air Force) to begin negotiating the use of Alcantara, I was informed that the command at Alcantara was not interested. Although we could manage without Alcantara, the site does offer an option in event Natal does not launch an ozonesonde or is not within range of the ephemeris.

The agreement presently in place with the USAF at Patrick AFB arranges for the personnel in Ascension Island to launch ozonesonde balloons once per week (part of SHADOZ). However, SHADOZ may not continue into the period when SAGE is on-orbit. An extension to the agreement is possible and is not expensive. Present costs is approximately $12000-15000 per year.

I. Expendables and Hardware

To date, equipment as necessary to sustain the measurement program is maintained as required, and up-dates to the system are continually incorporated. Contractor personnel process ozonesonde data and prepare up-dates to the data formats, directories, and file maintenance procedures. Expendables maintained on hand and/or purchased, as required, to enable validation of SAGE III, when launched. Special test flights and investigation into accuracy and instrument improvement is a continuing effort.

Data formats have been revised to enable ozonesonde data to be archived in the World Ozone and Ultraviolet Data Center (WOUDC) in Toronto. NASA secured data have been submitted to WOUDC since the late 1960's. A new format was completed to allow the data to be archived in the AMES format at NCEP as part of the Network for the Detection of Stratospheric Change (NDSC). Finally, all of the NASA ozone data are archived at Wallops and can also be found on the UAIRP homepage.
http://uairp.wff.nasa.gov/

Tests have been completed to determine the effects of different parameters on the ozone reduction quality. Dual radiosondes were flown to determine the difference between using 1 percent buffered KI solution vs 2 percent unbuffered KI solution. The results are

seen in Figure 2. Considering that the same method to determine pump efficiency is used for both ozonesonde instruments it was learned that the 2 percent unbuffered KI solution results in the measurement of less ozone (~10 percent). This is important since there has been an effort over the past few years to change solution strengths, apparently without evidence for which is correct. Furthermore, the background current usually encountered at release of the instrument into the atmosphere has been of concern. Instruments flown with ozone destruct filters indicates that the background current will remain close to zero _A. The tests did show an increase in the background current in the first few km after launch before returning to zero. This appears to be an influence from atmospheric pollution, but we have not yet done any research into this area.

I. Total Ozone

During 1998 the Dobson located on the island was moved to a new location on the airport. This instrument was recently (May 1999) calibrated by CDML (NOAA Labs) in May 1999. This calibration was practically unchanged from the calibration done in 1995. A handheld photometer (Microtops) available from Solar Light has been under comparison with the Dobson. The Microtops tracks the total ozone measured by the Dobson within about 1 percent. It is our intention to use the Microtops at sites where Dobsons do not exist to provide total overburden measurements (form NASA projects). A handheld photometer was sent to Ascension Island and personnel trained in its use.

I. Ozonesonde Intercomparisons

Testing of the ozonesonde capability is periodically conducted. The accuracy issue of the Electrochemical Concentration Cell ozone instrument is of concern to everyone using this instrument. Our laboratory testing and dual flights is helping identify those parameters that need to be studied carefully, i.e., pump efficiency and background current. During July 1999 comparisons were scheduled between the ozonesondes and the ALOMAR lidar. This effort was conducted during the DROPPS Campaign when NASA personnel were traveling to Norway.

Issue:

The proposal in response to NRA-97-MTPE-03 was intended to provide ozonesonde support only for SAGE III. E-mail received and recent information suggests that the proposal activity ought to be addressing the complete EOS ensemble of instruments. There is much synergism built into the UAIRP effort in situ measurement program, thus better temperature and humidity profiles can be made available from Wallops Island and other locations. At the other locations additional ground support equipment would be necessary. I believe there is an opportunity to provide valuable in situ measurements for SAGE III, TERRA, AQUA, AURA, and other remote instruments measurements. I do not believe there would be a problem providing validation measurements in situ for any of the EOS systems except the proposed and presently approved budget did not intend to provide support for anything else but SAGE III.

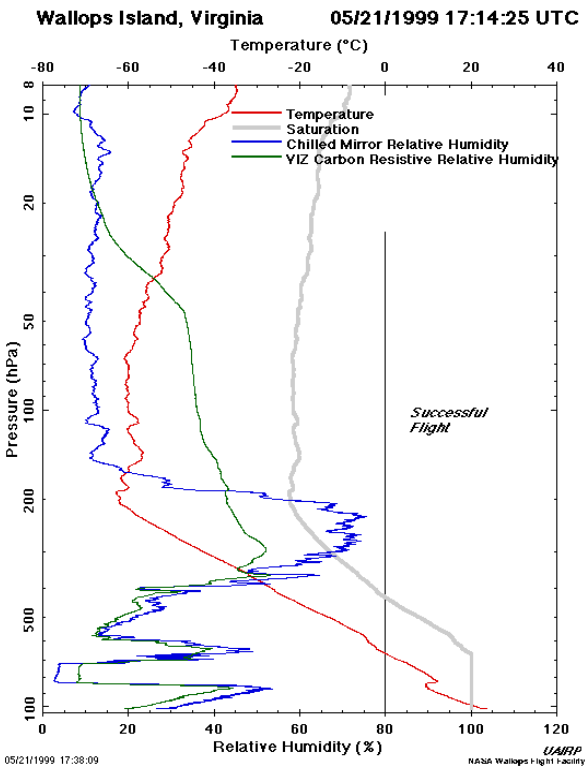

Figure 1 gives an idea of how the chilled mirror agrees with the routine relative humidity sensor. It clearly is capable of depicting cirrus when these clouds may be obscured from the ground, also temperature of the cloud tops are possible since the chilled mirror outlines the cloud quite well. The issue of aerosol effects on SAGE III measurements were discussed. We have managed to purchase the Micro Pulse Lidar provided by Science and Engineering Services, Inc. This lidar can provide vertical profiles of the aerosol optical depth. If clouds are present the optical depth to the base of the cloud is possible. The Science Team Meeting provided much useful information and the number of contacts increased. The feeling I got from the meeting was that there were some who were aware that validation measurements were needed and were going to be provided, and there were some who didn't know that GSFC had the capability to provide much in the way of in situ measurements.